Percutaneous Dilational Tracheostomy

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KEYWORDS

• Percutaneous dilational tracheostomy • Chronic respiratory failure • Critical illness

KEY POINTS

- Indications for percutaneous dilational tracheostomy (PDT) include but are not limited to upper airway obstruction and respiratory failure requiring prolonged mechanical ventilation.
- PDT is often performed at the bedside under bronchoscopic visualization.
- The use of ultrasound for preoperative screening and intraoperative guidance may be helpful; however, the data are limited.
- When performed by experienced operators, PDT is a safe procedure with minimal complications.
- A multidisciplinary PDT team has been shown to have significant benefits on performance and complication rates.

HISTORY

The human endeavor of making an incision into the windpipe in order to relieve an obstruction to breathing dates back to antiquity. Two ancient Egyptian tablets from 3600 BC depict a lancet pointed into the neck of a seated person.[1] The *Rigveda*, a sacred Hindu book published around 2000 BC, references tracheotomy; Alexander the Great (356–323 BC) reportedly used his sword to open the trachea of a choking soldier. The concept was described in 160 AD when Galen, a famous physician of the Roman empire, stated, "if you take a dead animal and blow air through its larynx (through a reed), you will fill its bronchi and watch its lungs attain the greatest dimension".[2]

In the seventh century BC, Paul of Aegina, a Byzantine Greek physician, described tracheotomy for therapeutic purposes in his medical encyclopedia, *Medical Compendium in Seven Books*, to prevent suffocation from inflammation of the mouth or palate. The first percutaneous approach to tracheotomy was thought to have been performed many centuries later in 1626 by Italian surgeon, Sanctorio Sanctorius, using a "ripping needle" to introduce a silver cannula through the tracheal wall.[1]

Despite these sporadic recordings over the centuries, when the age of modern medicine approached, tracheotomy was rarely performed due to high associated mortality. In the final month of 1799, George Washington, recently retired as president of the United States, lay dying in bed (**Fig. 1**). His airway was severely compromised from a suspected case of bacterial epiglottitis. In only the year prior, the medical literature described a surgical technique allowing access to the trachea in cases of upper airway obstruction. However, as Washington lay gasping for air, a team of his closest and most trusted physicians decided against tracheotomy (a procedure considered highly experimental and radical at the time) and opted instead for bloodletting, removing 80 oz (2365 mL) of blood over

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Fig. 1. President George Washington on his deathbed with upper airway obstruction, surrounded by his most trusted doctors contemplating his treatment.

12 hours. Washington ultimately succumbed to his death, and debate still continues as to whether tracheotomy may have saved the first president's life.[3]

In the early twentieth century, tracheostomy gained popularity after the famous American surgeon Chevalier Jackson standardized an open surgical technique. Dr Jackson's approach was thought to have reduced the mortality associated with tracheotomy from 25% to 1%.[1] With the increased use of mechanical ventilation in the mid-twentieth century and the decreased mortality of the procedure, the practice of using tracheostomy tubes for prolonged ventilatory support became more routine and widespread.[4] In 1955, the physician, C. Hunter Shelden, and colleagues[5] described a percutaneous method for tracheostomy tube placement as an alternative to the surgical approach. Twelve years later, Toye and Weinstein used the Seldinger guidewire to improve its safety[1]; in 1985, Pasquale Ciaglia and colleagues[6] further refined the procedure, leading to what is considered the most popular and widely applied technique today for percutaneous dilational tracheostomy (PDT).

INDICATION

Indication for tracheostomy tube placement falls into 2 broad categories: for relief of upper airway obstruction and as an alternative method to endotracheal tube (ETT) intubation for prolonged ventilator support and long-term airway maintenance. However, other uses exist (**Box 1**).

In the setting of upper airway obstruction, the method by which to secure the airway often depends on the clinical scenario and emergent nature of the obstruction. Causes of upper airway obstruction must be considered in guiding the management plan, with causes that include maxillofacial trauma, laryngeal injury and edema, obstructing upper airway tumors, and other benign anatomic conditions that render laryngotracheal intubation difficult to perform.[7] In an emergency due to an inability to maintain airway patency or ventilate using standard techniques (bag mask, laryngeal mask airway, or ETT intubation), PDT is often not the initial procedure of choice but rather rapid cricothyrotomy (via an incision through the cricothyroid membrane) or surgical tracheostomy.[4] Although PDT can be performed emergently,[8,9] it is generally accomplished in a more controlled setting.

Prolonged ventilator dependence remains the most common indication for tracheostomy, thus, acting as an alternative to ventilation via an ETT.[7] Underlying conditions can range from intrinsic respiratory failure to debilitating systemic or neuromuscular illness that requires chronic airway protection or ventilator support. The benefits of prolonged ventilation via a tracheostomy tube over an ETT have been proposed. These advantages include an enhancement of patient comfort, improved oral hygiene and pulmonary toilette, allowance for oral nutrition and speech, and easier mobilization and engagement with physical

Box 1
Potential percutaneous dilational tracheostomy indications

- Prolonged intubation
- Improved comfort and mobilization while on mechanical ventilation
- Relief of upper airway obstruction
- Severe obstructive sleep apnea
- Bilateral vocal cord paralysis
- Inability to ventilate from underlying systemic neuromuscular disease